Application of 3D Optical Wannier function method to Micro-circuitry 2D-3D Photonic Band Gap Heterostructures

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The finite-difference time domain (FDTD) method has been the workhorse for simulating optical propagation in photonic crystals. Typically this involves discretizing the 3D unit cell of a PBG material with more than 1000 points on which the vector field amplitude is defined. For complex 3D circuit paths, this becomes computationally cumbersome. The same information can be efficiently recaptured by representing the optical field in a 3D system as an expansion in small number of Wannier functions, the optical analogue of atomic orbitals in electrons [1-3].

We introduce the application of 3D optical Wannier function method to photonic crystals. We research Wannier functions in 2D-3D photonic band gap heterostructures [4] composed of 3D woodpiles, square spirals, and slanted pore architectures with 2D defect layers. By expanding electromagnetic fields by maximally localized Wannier functions, it becomes possible to calculate guided modes and transmittances in 3D circuit paths with optical devices in 3D PBG materials.

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